DATA PROCESSING DIGEST

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General Information

THE ARITHMETIC OF COMPUTERS

Norman A. Crowder, Western Design, Santa Barbara, California
To be published by Doubleday & Co., New York. $3.95

In the February 1960 issue of DPD on page 6, we reviewed an interesting little book titled "Automatic Teaching: The State of the Art." One of the papers which made up the contents of this book was concerned with "intrinsic programing," a method of teaching binary arithmetic through the use of a unique text book. A student could learn his subject almost entirely without supervision or outside help because the format of the book forced him to progress only at his own speed.

Now we have seen a preprint of this text book, which will be ready for the trade this month. It is one of several books trademarked TutorTexts by Doubleday & Co., publishers. The teaching method and format of this edition were designed by Norman A. Crowder, Manager of Training Systems Department of Western Design, a division of U. S. Industries, Inc. An earlier edition was written for an experimental study with sixth graders in the public schools in Santa Monica, California.

Seldom has a text book impressed us to the extent that "The Arithmetic of Computers" has. It is not only unique, but actually great fun to read. (How many textbooks have you found fun to read?) The student opening a TutorText and reading the first page is captivated -- he finds he is playing a game with himself that is both engrossing and challenging. To best describe this unique learning experience, we quote from the book's preface:

"The presentation of material in this book approximates, as nearly as possible, a conversation between a tutor and his pupil. The TutorText offers information in rather small units and tests the reader's understanding by means of multiple choice questions -- which the reader must answer in order to proceed further in the book. A wrong answer leads to more discussion of the same point of information; a correct answer leads to the next unit of information and the next question. Self-test questions at the end of each chapter provide additional drill."

CONTENTS

Does this sound pedestrian? Not when you must choose an answer and then turn to the page given next to it to see if you were right or wrong! Here's what you see if you selected a wrong answer:

"Your answer: $3^0 = 0$. You seem to have gotten off the track somewhere. Return to page 61 and review the material from that page foreward."

or:

"Oops, you multiplied the exponents instead of adding them."

or:

"Let's backtrack a little."

or:

"Now, now, you're getting excited."

or:

"No, you found the sum of the absolute values."

This kind of breezy conversational style is what keeps up the student's interest and makes each new page a surprise. Don't think this is just for sixth graders, either. While a smart sixth grader could certainly understand it, any adult who grew up thinking God created the decimal system can benefit from this course in understanding number systems. "The Arithmetic of Computers" introduces the student to the meaning of binary and octal systems. Other TutorTexts are promised in related subjects. And for the bridge hound, there is a TutorText by Goren due in October, too.

GAINING ACCEPTANCE FOR MAJOR METHODS CHANGES

Ben Miller, St. John's University
American Management Association Research Study #44

Six case studies were made of companies which had installed improved methods in their offices--either punched card or computer installations. The result of the survey "presents evidence which tends to cast doubt on previous ways of dealing with the human problems that arise with the coming of major changes in methods. The increasing applications of office automation... are destined to be retarded by these human problems."

Sources of conflict in setting up the new systems included:

1. Inept approach of methods analysts in dealing with others.

2. Overdependence on methods analysts from outside.

3. Manpower shortage in the changeover.

4. Management pressure for early installation.

5. Lack of participation by supervisory employees.

6. Poor planning for transfers and reclassifications.

7. Insufficient information.

At least one surprising reaction to the methods changes was found:

Old dogs are top dogs at learning new tricks

1. Older persons are superior in coping with the change--in contrast to the widespread belief that older people are more inflexible.

2. Negative attitudes among supervisors and employees were more pronounced than among managers or methods analysts.

3. Methods analysts had the most favorable attitude toward change.

4. The attitude of managers was less positive than that of methods analysts.

5. The attitude toward change was more positive several months after the installation than it was during the change.

Recommendations for success of the installation include:

1. Appoint an automation committee in which every group to be affected by the change is represented.

2. Begin an education campaign as soon as the automation committee is organized and continue it until after the installation has been completed.

3. Plan a program of conferences with managers, methods analysts, and supervisors to study the changes and the problems they may create. An outside conference leader to lead the discussions would be desirable.

Have a supervisory development program

Since it appeared from the survey that the supervisors and rank-and-file employees were those most resistant to change, it might be desirable to establish a supervisory development program that would provide supervisory personnel with an understanding of the organization and the necessity for change. The author's experience has been that the best results are found in companies which have full-time qualified methods analysts or systems specialists. Small companies which cannot afford a full-time person for this function might assign one of their employees to such duties on a part-time basis. Also, the personnel director

should be involved in planning any changes, perhaps by the assignment of a member of that department to the methods group responsible for the change. Older employees should be included in planning, as they have the greatest accumulation of knowledge about the company's operations, and the strongest identification with the objectives of the company.

The case studies included a paper products company, a telephone company, a drug company, a public utility, and two commercial banks. Revealing quotations from some of the interviews with the employees are included in the case studies.

A copy of this research study may be obtained from American Management Association. Price: $1.50 for AMA members, $2.25 for non-members.

DATA PROCESSING TODAY: A PROGRESS REPORT

AMA Management Report #46

Papers presented at the Sixth Annual Data Processing Conference of the American Management Association in March 1960 are included in this report. While all the papers are excellent, we are selecting several for special mention. Among these is "Data Processing and the Management Information System" by Milton M. Stone of Arthur D. Little, Inc. He suggests that most EDP planning has concentrated on the equipment and the techniques of data processing and not on the reason for having data. Data processing is the "conversion of data into information," and in the design of a management information system three questions must first be asked:

Three steps to Information System design

1. What is the management job to be done (the expected or desired results to be achieved by the manager)?

2. What is the information needed to do the job (operating information, decision-making information, and performance measurement)?

3. What methods are to be used to convert data into information (specific techniques of data analysis and data processing)?

"A complete solution to the business intelligence problem--a management information system--can result only from this penetrating three-step search for a clear definition of the data-processing problem. Once these three questions have been answered, inputs and outputs can be specified and the techniques of processing implemented. It is these latter tasks, unfortunately, that have been the starting point of most planning for data processing to date."

"The word 'system' in the term 'management information system' does not imply complete dependence upon a 'feedback' concept

of running a business 'untouched by human hands.'" What it does imply "is the need, in developing information for any level of management or supervision, to interrelate data--that is, to consider the various ways in which all the data available can be organized and manipulated to produce an interrelated body of useful data, or information."

The system will keep changing

Probably no information system will be able to exist without change from its original conception. But "when a change occurs in the nature of your company's business, in the way your company is organized, in the competitive situation, in the laws governing your industry, or in the economy of the nation, there will be an accompanying need for new patterns of information. Heed not the moans and groans of the data-processing technicians.... Instead, demand that the management information system be capable of responding quickly to the new situation; insist that the inconveniences of technique modification be subservient to the urgency of the new information needs--that the manual and machine elements of the data-processing system be flexible and not rigid, and thus capable of being realigned. If good systems thinking has been used, this requirement can be met."

There is a need for professionalism in the design of management information systems. Today's team approach with staffs of "narrow experts and facile coordinators" can't sell new information products as a professional can. From whatever source the new management information professional comes, "his arrival will herald the next exciting phase in the use and processing of data: the practical realization of the concept of the management information system."

Data transmission tests

"Data Transmission: Some Current Developments and Prospects," by Frank H. Muns of Westinghouse Electric Corp., describes some of the tests Westinghouse has been using on data transmission devices. They have experimented with teletype and telephone lines, with the AT&T digital subset, Avco's Comex (paper tape transmission), Collins Radio Kineplex (magnetic tape transmission). Other companies have tried microwave systems, and facsimile transmission by television techniques is being investigated. These wider bandwidths, while more expensive, carry so much more data that, if fully utilized, they would cost only a little more than one per cent more than the lowest-cost teletype circuit.

"On-Line Computer Control of Chemical Processes," by James M. Madigan, B. F. Goodrich Chemical Co., relates the way in which this company developed a mathematical model of two chemical operations. The computer performs other management computations in between its use for controlling the production.

Three papers, by Donald M. Hart, Kenneth J. Soderstrom, and James E. McGuire, are good examples of the way in which OR is being used in conjunction with computers.

WHAT BUSINESS NEEDS MOST FROM E.D.P. MACHINE MANUFACTURERS

Benjamin Conway, Price Waterhouse & Co., New York
N.A.A. BULLETIN, August 1960; pages 67-73

What the customer needs from the equipment manufacturer

Some of the requests business organizations are making of computer manufacturers are listed. Among them are:

1. Business users would like to have accurate specifications on the proposed system.

2. Rental structures should be revised downward for the early stages of an installation. It is suggested that this could be done by reducing initial costs and increasing second and third shift rentals.

3. To help reduce intial costs, manufacturers should introduce programing aids very early in the installation. Also, they should encourage the customer's liaison with user groups.

4. The manufacturer should help the user in drawing up a realistic program timetable and setting a reasonable delivery date.

5. The manufacturer should provide adequate breakdown coverage on standby equipment reasonably close to the customer.

6. The manufacturer should supply adequate detailed information for site preparation and air conditioning.

7. The manufacturer should provide representatives who are fully trained both in the equipment and its use and in teaching principles, and should provide adequate training material and tests for the students. The representative should also be prepared to comment on the suitability of any student if it appears during the course that he would not fit into a programing group.

8. Debugging routines should be available, along with adequate machine time for the user's program testing.

9. The technical representative assisting the user should not be changed until the initial programs are operating satisfactorily.

10. The manufacturer should ensure that the computer is adequately maintained, both in servicing by an expert maintenance man, and in an adequate source of parts and supplies on the user's premises.

Cheaper computers and better data transmission

Business will be making other requests from manufacturers in the future. For example, since most large companies, or companies in which money for new projects is available, will already have made their approach to electronic data processing, potential users will be concerned with cost, and more likely to be interested in cheaper equipment than is now available. Therefore, there should be a class of machines which will do the work now done by the present medium and

small-scale tape-and-card systems at much lower total costs. If such equipment is not possible, manufacturers should say so publicly. This reduction in cost appears to be a more desirable trend than aiming at increasing machine capacity and capability.

In communications, faster transmission and better methods of editing during transmission and error detection and correction will be desired. In random access, "if a system of several million character capacity could be developed at the same total system cost as with mass magnetic tape storage, then present methods of processing could be completely changed and many applications not presently suitable for electronic data processing would fall easily into place."

Development of a universal machine language and systems packages will relieve people from the drudgery of coding, and allow them to take advantage of the experience of others in similar work. The impetus for this must come from the machine manufacturers. Those manufacturers who do develop the systems approach will have a tremendous advantage over the others.

RETAIL RESEARCH INSTITUTE

Among the papers presented at the Second Annual Retail Research Institute Conference of the National Retail Merchants Association in San Francisco, February 1960, are several of interest in the field of EDP. The retail industry has shown increasing interest in optical scanning as the most likely method for automatic input in an integrated EDP system.

Optical scanners for retailers

Two of the papers at the February meeting discuss optical scanning from the manufacturer's viewpoint. One of these is the Farrington Manufacturing Company, one of the first to place practical scanning equipment in industrial uses. This paper is a clear and interesting explanation of the concept of a scanner, and the problems to be solved in its design. The other paper is presented by National Cash Register. This one concentrates on the specific problems of the retail store, and shows how this manufacturer has gone about the task of designing scanning equipment to tie in with present cash registers and accounting machines. Their problem has been to design a scanner capable of reading accurately the vagaries of printed output on cash register tapes and accounting machine documents, as well as customer charge plates, whatever the quality of the paper and ink. Excellent magnified views of example printing illustrate the scope of the problem. NCR's solution to this problem is the development of a type face that is easily read by humans, but with certain code characteristics which are read by the scanner. This solution provides good tolerance for relatively poor printing, and keeps the electronic design of the scanner fairly simple. In addition, it is both reliable and compact. Print wheels in present equipment can be easily and inexpensively converted to the new type face.

Fast customer service is system design requisite

A third paper describes the inventory control system of Montgomery Ward, as set up presently at the Allen Park distribution center in Detroit, and as planned for San Leandro, California. Allen Park serves 80 retail stores and 37 catalog stores in five surrounding states. The goal was to deliver merchandise within 42 hours from the time the order is mailed. To do this, the extent to which inventory should be controlled was carefully considered. In order not to impose upon local stores a centrally conceived inventory, they provided model stock quantities for each item for each store as a suggestion to the store manager. To keep managers from stockpiling items, the company set up its fast delivery system, backed up by an efficient electronic inventory control system at the distribution center.

Customer orders are received early each morning, and are processed first. Store delivery orders are grouped according to truck departure time and processed in groups of about 500 line items. All orders are processed by the IBM Ramac. Output of the computer is: order fill tags sent to the warehouse, shipment check list printed from accounting cards which are then filed for weekly printing of the charge register; back order cards sent to merchandiser for reprocessing when merchandise is again on hand; merchandise summary cards which update the merchandiser's records; stock level notices and emergency reports. At present the new San Leandro distribution center is being handled manually, because of a shortage of manpower to design another EDP system and as a comparison with the present Allen Park system. However, this center will probably be set up very soon in a similar fashion.

For information on these papers write to the Retail Research Institute, NRMA, 100 West 31st St., New York 1, New York.

THE ACCOUNTANT'S CONTROL OVER ELECTRONIC COMPUTER SYSTEMS

S. W. Skipworth, Alexander Grant & Co., Los Angeles, Calif.
COST AND MANAGEMENT, July-August 1960; pages 254-262

The accountant can help design a company's EDP system by informing the programing staff of his requirements, and by establishing control points. Control divides into three parts: control outside the computer runs, control within the computer runs, and reliability of the computer. Verification of input information may be done in any of five ways:

1. Originally prepared and put through a verifier. This requires duplicate typing or keypunching, with equipment locking if any differences are detected.

2. Complete preparation of duplicate input with computer proofreading.

3. Manual proofreading of hard copy produced at same time as computer input medium.

4. Input medium of one computer run is output of another.

5. Punched card output of a tab installation is used as input to a computer.

Is this verification economical?

Sometimes verification would cost more than the error or function it is meant to control. The auditor is interested in the accuracy of the final printed product of the system. If the computer is functioning properly, and the program is correct, his chief concern will be with the printed output. He should determine to what extent this equipment is self-checking, to what extent programing or wiring can be tampered with to inject fraud, and to what extent operator intervention can inject accidental or deliberate data manipulation. Within the computer runs the auditor can trace the application requirements in the programer's manual into the various routines. Since it is possible that during the programing phase changes are made which are not reflected in the flow charts, he should make sure such changes are brought up-to-date. In reviewing the flow charts and programs, the auditor is looking for block count and item or record controls; item sequence testing; input and output tape label checking; ability of the program to handle both good data and exceptions.

Test the program with samples

One way of assuring the adequacy of the program is for the auditor to prepare a dummy list of every possible type of transaction, transcribe those transactions to the input medium of the computer, and test the program. The auditor should review the computer log to find the degree and variety of troubles the installation had during the audit period. If the errors do not seem to be functional, he should discuss the possibility of equipment failure with the manufacturer's maintenance technicians or engineers.

In using the computer to audit its own data, three factors must be considered:

1. Can you logically determine values against which the computer can compare for equality or magnitude?

2. Can you foresee all of the abnormalities for which you are auditing and insert them into the computer as constants, or computer test for them in some other manner?

3. Is the volume of data great enough to warrant use of the computer in this manner?

COMMUNICATIONS OF ACM

The June 1960 issue of the ACM Communications contains a number of articles which we would like to mention for the benefit of persons who do not belong to the Association for Computing Machinery. First, there is a provocative talk ("The Future of Automatic Digital Computers") by Andrew D. Booth, well-known in British computing circles, reprinted from The Computer Bulletin, in which he says that he finds the immediate past of computers a disappointment, and that "far from thinking that any second generation computer exists, I think that we are only just seeing the growing up of first generation computers." His remarks include hardware and components design as well as micro-programing and time-sharing.

"Compiling Connectives" is a paper by Charles J. Swift of Computer Sciences Corporation, which describes the methods used by the FACT compiler (Honeywell 800) in using connectives.

A fast computer should be able to schedule its own workload using a scheduling routine which may be executed rapidly enough that the process will not be self-defeating. The construction of such a schedule is the subject of "Multiprogram Scheduling," by E. F. Codd, IBM Corporation.

MACHINE ACCOUNTING FOR TAX AUDIT

William W. Eaton, C-E-I-R, Inc., Arlington, Virginia
TAXES, June 1960; pages 441-444

In many EDP systems "significant savings... are being whittled away because the programmers of systems do not take into account the needs of federal, state and local taxing authorities; federal regulatory agencies, etc." Basically, the needs of governmental agencies and business management are not incompatible. For example, in the problem of depreciation, printout records such as inventory verification and valuation, asset remaining value report, and depreciation expense report by departments are visible, readable records used by management which can also be used by governmental agencies. "These printout registers provide a much needed audit trail from tax return to source documents; the machine printouts, as well as the source documents, should therefore be kept as long as their content is material in the administration of any federal state and local taxes." The machine printouts should contain a coded reference to the original source data to facilitate the audit trail.

Similar tax use can be made of reports on the repair account, bad debt activity, and advertising expense records. Most public accountants are aware of tax authority requirements, and should be brought into system design activity to anticipate all the tax information that may be needed. The additional cost of programing for this is neglible compared with the cost of providing the information later on.

A KEY TO SUCCESSFUL CHECK ENCODING

BANKING, August 1960; pages 132-134

One of the problems in MICR that worries bankers is how to handle the uncontrolled items--the checks that are provided by commercial accounts for their own use. Actually, when banks begin their MICR program, they find this problem does not exist. Customers show a willingness to comply with the A. B. A. standards, and check suppliers are meeting the requirements in the printing of the checks. Some banks are underwriting the additional cost of about 5%; other banks are avoiding any commitment to take on this additional cost. Some banks found that some of their customers were already planning for the change when they first approached them. Even changing the design of the commercial check, altering of internal forms and systems, and encoding for accounts in a number of different banks have not been insurmountable problems for commercial customers.

BEFORE YOU AUTOMATE

Burt K. Scanlan, University of Nebraska
BANKING, August 1960; pages 74, 154, 156

In order of occurrence, here are five areas of work which banks must do in order to install an EDP system:

1. Gather data concerning the present operation.
2. Install a system of numeric account numbers.
3. Plan a program of customer and personnel education.
4. Alter present procedures to fit new system, and make continual adjustments as the need arises.
5. Time the installation during slack periods.

CONTROLLED PLANT INFORMATION

FACTORY, August 1960; pages 61-81

A good general overall view of the need for adequate information processing in the factory is directed toward the plant manager who knows he needs better information, but has not yet been touched by an organized system engineering project. Data processing from its simplest to its more complex electronic form is described in terms particularly suited to the factory situation.

GLOSSARY OF TERMS USED IN AUTOMATIC DATA PROCESSING

A small 40-page booklet published by Business Publications Ltd. (Mercury House, 109-119 Waterloo Rd., London SE1, England) contains a very excellent EDP glossary. It is professional rather than for the beginner-layman, and appears to be useful for the serious student, or personnel involved in some aspect of an EDP installation. Price: seven shillings and sixpence ($1.05).

GLOSSARY OF TERMS IN COMPUTERS AND DATA PROCESSING

Edmund C. Berkeley and Linda L. Lovett
Published by Berkeley Enterprises, Inc., Newtonville, Mass.

The fifth edition of the "Glossary of Terms" previously printed in a regular issue of Computers and Automation is printed in a small 90-page booklet. This edition is nearly twice the size of former editions, and covers the hardware and programing aspects of computers. Price: $3.95.

NEW PUBLICATION

A new quarterly publication in the data processing field made its appearance in July. It is called "Data Processing and Microfilming Systems." The editorial which introduces the magazine to its readers states "The backbone of our magazine will be the presentation of case histories that show how organizations are handling their information management problems in such varied areas as banking and finance, insurance, research and development, engineering, retailing, wholesaling, transportation, government, military agencies, universities. We will point up the systems that others have found most effective for consideration by readers who may have similar problems. In addition, we will feature discussions of new developments and techniques as they develop." The magazine's audience is "information and systems management specialists, the people responsible for collecting, recording, retrieving, processing, evaluating and distributing information.... Their tools are varied...electronic data processing and magnetic tape, aperture cards, microfilm and microforms, recordings, and paper records."

The first issue includes articles on photomemories, microfilm, EDP in retailing, American Bosch's Management Operating System, and The Harris Trust and Savings Bank installation. The material is presented in an interesting and professional manner. We are sorry to see, however, that the general layout of the publication is so similar to at least two others in the field as to cause some confusion.

A GUIDE TO U.S. INDEXING AND ABSTRACTING SERVICES IN SCIENCE AND TECHNOLOGY

The Library of Congress, Washington, D.C.

An extensive index of indexing and abstracting services is published in an 80-page booklet. The fields covered are General Science and Technology, Mathematics, Physics, Chemistry, Biology, Science of Man, Medicine, Earth Sciences, Agriculture, and Technology. Both domestic and foreign services are listed. ((DATA PROCESSING DIGEST is listed on page 8.)) For information, write to Reference Department, Science and Technology Division, The Library of Congress, Washington 25, D. C.

COMPUTER ABSTRACTS

A new abstracting service is Computer Abstracts, published in England by Technical Information Company Ltd., Chancery House, Chancery Lane, London WC2. The monthly runs to about 20 pages of approximately 20 abstracts per page, along with an author index. Included as a separate insert is Computer News, a four-page sheet of news items. The service is available at $96.00 per year, which includes a document procurement service.

THE STANDARDISATION OF DATA PROCESSING ANCILLIARIES

AUTOMATION PROGRESS, July 1960; pages 234-237

The British Standards Institution has undertaken to establish standards for data processing equipment, components, and symbols. Those standards already established or well on the way include: alpha numeric punching codes for cards, physical properties of punched cards, coding for 4, 5, 6, 7, and 8-track punched paper tape, and physical and magnetic characteristics of magnetic tape. Other standards to be established are for: drop-out and drop-in (spurious signal) tests for magnetic tape, tape spools, high speed printers, printing forms, input keyboards, card readers and punches, and definitions of terms.

AUSTRALIA INVENTORIES ITS DATA PROCESSING PROSPECTS

CONTROL ENGINEERING, August 1960; page 35

The First Australian Conference on Automatic Computing and Data Processing held in May 1960 revealed the wide interest in EDP even though Australia is about three years behind Great Britain and the U.S. There are 28 computers in Australia now, with 35 on order. All

of them are imports. Insurance companies lead in the use of EDP. ((See also "Globe Girdling Grosch Reports State of Art in Australia, Japan," July-August issue of Datamation, page 31.))

Systems Design

CENTRALIZED RECORD KEEPING FOR DECENTRALIZED OPERATIONS- DEVELOPMENT OF DATA PROCESSING APPLICATIONS

George R. Bynum, North American Aviation, Inc., Los Angeles, Calif.
N.A.A. BULLETIN CONFERENCE PROCEEDINGS, August 1960; pages 12-17

North American Aviation Corp. has six divisions, five of which are in the Los Angeles area. The sixth one is in Columbus, Ohio. Six computers serve the five Los Angeles divisions. Each division is responsible for its own input to the computer system, but the responsibility for administering all data processing operations rests with the corporate office integrated data processing department, which reports to the office of the corporate controller. In each division the data processing department reports to the division controller. These departments are responsible for the equipment operations and for the accuracy of all input to the computer system.

Solution to problem facing systems man

The two divisions in which the large-scale computers are located are about thirty miles apart and are connected by means of a micro-wave system which can transmit information at magnetic tape speed. Other divisions in the Los Angeles area will be linked to this system in a similar manner. At present an average of fifty reels of magnetic tape a day are transmitted between the two computer locations. Data is processed in a centralized manner. For example, payroll is processed on a corporate basis and then split off by divisions, enabling the company to keep information for reporting Federal and state taxes in a central location. Paychecks are written in the computer room, but the tapes are then sent to the different divisions for preparation of their own registers.

Labor distribution is also centrally processed for each division, and all labor costs on one contract, regardless of the division doing the work, are processed as one report. Labor distribution tapes are then sent to the divisions for their use. Each division determines for itself what information and reports its management needs and what areas can be mechanized most profitably. Each division also performs its own systems work; however, this is coordinated through the general office programing staff so that one division can take advantage of systems and programs developed for another division.

The company prefers several large computers to many small ones because "large computers offer opportunities for fully integrated

systems which are denied the limited capabilities of the small machines .... By grouping our computers in two main locations, we are able to have better supervision and a higher concentration of specialized skills than if we had several more locations. Also, the utilization rate of both the computers and skilled personnel is much higher."

CONVERTING TO ELECTRONIC DATA PROCESSING

DATA PROCESSING (U.S.) July 1960; pages 29-31

Consolidated functions vs selective applications

Before management can convert to EDP, it must decide whether the conversion will be by consolidated functions ((total systems approach)) or selective applications. "The consolidated functions approach usually entails a preliminary analysis of the company's total business problems and an initial design of a comprehensive, integrated program repertoire." Management and the systems group together must decide "1) what kind of data will be processed, 2) what types of reports will be expected, 3) who will use the information, 4) how many applications will be programed and in what order 5) what length of time will be allocated for conversion and what personnel will work on it. Not until all analyses and the major part of programming are completed is the new system put into full operation; at that time, a large number of integrated programs are converted to EDP simultaneously."

Advantages of the consolidated functions approach are the ability to "secure from a computer system advanced control techniques that may increase efficiency of many company operations not directly tied into the computer system"; and the broad education and training management and programing personnel get in the optimum use of a computer system. Disadvantages in this approach come from the loss of time in getting the new system into full operation. Often an outside consultant is retained to assist in this type of system.

In the selective applications approach, a company converts to EDP application by application. The first program is usually the most urgent one, thus the computer begins to pay for itself in the first months of use. Usually the conversion is handled in the parallel operation of the old and new systems. It usually requires less than a year to get one or two programs converted, compared with two years conversion time for the consolidated functions approach.

A RE-EVALUATION OF GENERALIZATION

R. C. McGee and H. Tellier, Hanford Atomic Products Operation, Richland, Washington
DATAMATION, July-August 1960; pages 25-29

((See also: DPD April 1959, page 1 or IDEA FINDER, page 131: "Generalization: Key to Successful Data Processing"))

The Generalized Routines developed at Hanford have been refined by IBM 709 users and are now called the 9PAC System. Maintenance of the system is being performed by IBM Applied Programing.

Building block approach to data processing

Generalized routines were developed as a result of a study of the effort being expended in a computing system which showed that 80% of running time was spent on manipulation of data to maintain files, sort records, and prepare reports. It was concluded that any data processing system could be organized by use of the four functions of sorting, file maintenance, report preparation, and calculation. This building block approach to data processing assumed the existence of subject source files--a collection of data on a broad subject, such as all the information on personnel. When the source files are correctly defined and the right kinds of information are included, the number of such files for a business is relatively small. During installation of the EDP system, the building blocks can be distributed among a number of workers with a minimum of coordination necessary.

Generalized routines differ from compilers. A compiler translates instructions written in a pseudo-language to the language of a particular machine, and generally the organization of the instructions is entirely under the control of the programer. A generalized routine is a program which is capable of obtaining a solution to a particular problem or class of problems (e.g. sort, prepare report, etc.) The structure is fixed. Variability may be achieved by modifying the structure of a basic program through preliminary processing, or by use of a generator in which the entire program is reconstructed from short sequences of precoded instructions prior to each processing of a program. Hanford's generalized routines are of the latter type. The fixed structure of the generalized routines leads to economy in programing because it is not necessary to write instructions or do logical planning to determine what the structure of the object program is to be.

Source language describes desired ends

The source language of the generalized routines is unique in that it consists of descriptions of desired end results. The descriptions are recorded on pre-printed forms which are then keypunched and packeted by descriptions. This is quite different from the classical approach to programing in which a process which will lead to an end result is described. In generalized routines only the end result is described, and the process to be used in achieving the end result is determined by the generalized routines.

One use of the generalized routines is in providing special reports upon request. To do this, the operator places the packet de-

scribing the special report into the card reader with the normally processed packets and the special report will be developed at virtually no cost, as a by-product of routine processing. Preparation of the packet for the special report is the only human effort required.

By using generalized routines, drastic changes may be made in the detail structure of a file without re-writing a single instruction. It is also possible to add or delete fields and to add entire new record types with associated dictionaries to the file. In this way, broad areas of data can be integrated into single files, so that many applications can be processed from a common source of records.

Advantages resulting from a few large files

The construction of a few very large files, which results from the use of the generalized routines approach, has some advantages:

1. The ability to extract or cross-correlate any facts from the broad class of information in the file.

2. The ability to perform all processing on a given subject category in a few machine passes.

3. The ability to accurately control the data on a broad subject class in a single file thereby avoiding the difficulty of making several small files agree with one another

4. The ability to provide accurate and up-to-date information as inputs to scientific investigations, evaluations and forecasts of a business.

While there is nothing implicit in the generalized routines that requires the use and construction of large files, experience will show the extent to which it is desirable to integrate information into single files.

Generalized routines are more efficient than corresponding handwritten programs because they do not contain corrections or redundant programing included to make the program work when errors arose in the original writing; and each generalized program performs more work than a corresponding handwritten program.

INSTEAD OF A COMMENT...

We are happy to present in this issue the Computer Characteristics Chart which follows the Reference page of Data Processing Digest. This was compiled by Adams Associates, 142 The Great Road, Bedford, Mass., and is published with their permission.

Applications

HOW A COMPUTER EARNS ITS KEEP

John N. Raleigh, The United States National Bank, Portland, Oregon
BANKING, August 1960; pages 51, 52

A computer decides who gets a loan

Using a computer for consumer credit accounting, a job that is nearly as economical to do manually, can benefit the bank by doubling the late charge income. This is because the computer is catching all of the past dues where a clerk does not. However, "the computer will not have its full impact on consumer credit financing until it has actually started to make loans!" The U. S. National Bank, has, on a strictly experimental basis, programed their computer "to perform an editing job on loans that have already been made by a person. By giving the machine the same set of working facts that the officer had when he made the loan, we have been able to make it arrive at the same decisions--and have even found a couple of errors that had crept by him!"

Using this procedure for processing loans will not result in people losing their jobs--rather, good loan officers will be upgraded because the routine clerical portions will be done by the machine. "We'll be able to pay enough to get and to hold top quality men in positions offering far more dignity and responsibility."

Presently the U. S. National Bank posts more than 107,000 checking accounts for 27 of its branches, and for 20 of them, posts the general ledger; prepares the payroll for all 73 branches; handles the revolving credit plan (it takes 11 minutes a day to process 4000 accounts); prepares income tax for personal trusts (1000 returns in 10 hours); handles the accruals for all the commercial and real estate loans in the branches, and as a by-product, keeps a duplicate ledger record of every such loan, with the expectation that ultimately the branches may stop posting liability ledgers.

An honor system for service bureaus

If this seems as though the computer is loaded--not so. The bank finds it has plenty of computer time to rent to local service organizations that do work on a contract basis for their own customers. All materials and the operator must be furnished by the customer. Everything is on the honor system. Customers log in and out on a time clock. Scheduling is handled much like a dentist schedules his patients, and if a customer has a rush job, scheduled people are contacted to see if they can yield time. Usually they do, since they know they may need the same courtesy some time. The bank is averaging about $2000 a month from this source, and there is still time available. ((An IBM 650 has been the computer used in this system.))

WHAT A UTILITY HAS LEARNED WITH EDP

Roy N. Dreiman, Pacific Gas and Electric Company, San Francisco, Calif.
THE CONTROLLER, August 1960; pages 362-365

At Pacific Gas and Electric two million domestic and commercial customers' gas, electric, and water accounts, representing 3-1/2 million customers' meters, are now being processed by electronic computers. One hundred thousand bills a day are processed. Information is sent to 135 local offices for use in answering customer inquiries and for credit follow-up. Collection notices are printed, and statistical data and reports are prepared for management.

How the planning time was spent

The EDP staff spent a total of 489 man-months on the Revenue Accounting application. This broke down into: system design, feasibility studies and equipment evaluation, 30 man-months; recruiting and training, and further system design, 72 man-months; problem definition, programing, installation planning, conversion and operating procedures, 324 man-months; testing and preparation for operation, 54 man-months.

Some suggestions for designing a new system are given:

1. Design the EDP system to "take full advantage of the computer's facility to arrange one set of basic data into several different formats simultaneously."

2. Include in the system design study representatives of those departments whose methods will be adapted to EDP.

3. Study all related areas to achieve integration of design. "Computer runs should be designed to provide for logical progression of data through the system."

4. Obtain approval of the system, especially basic policies involved, before beginning the actual programing.

5. Coordinate staff assignments in the systems study to avoid duplication of efforts and unnecessary disruption of operations during the information gathering stage.

6. Remember that conversion plans are an integral part of the system design.

First application is the hardest

The second application is usually more easily handled than the first. PG&E's current new application is the processing of materials and supplies accounting and related purchasing and stores information. The whole job will be done within a year, compared with two and a half years for the customers' accounting application. Other applications include property taxes, plant accounting, payroll, cost and budget analyses, engineering and statistical studies.

PG&E's advice is to "get the largest [computer] you can afford rather than go from small to large, provided present volumes and foreseeable growth appear to justify a sizable computer within a comparatively short time. This will avoid re-design of system and re-programming--costly items related to EDP which should be kept to a minimum." Their rule of thumb is to "look for...those functions which involve large-scaled, relatively simple repetitive clerical or punched-card processing...preferably one, but not more than two or three should be undertaken at a time--and not more than can be programmed and ready for conversion within a year or two. Then relate the number of people engaged in those operations which can be done on the computer to monthly rental."

NEW TOOLS FOR TRANSPORTATION MANAGEMENT

E. A. Leslie, Canadian Pacific Railway

A paper presented at the 1960 Transportation Management Program at Stanford University in July 1960, describes the manner in which the Canadian Pacific Railway is using an IBM 705 (and soon an IBM 7080) computing system to handle many accounting and management information functions. At present 68 local reporting centers are connected by telephone or telegraph to the EDP center.

Computer shows unfair rate structure

An example of information now available for the first time is evidence on the cost of handling grain, which forms 26 per cent of the railroad's traffic and for which they receive rates set in 1899. This evidence, presented to the Royal Commission inquiring into the transportation situation in Canada, may bring relief. Other uses for the computer are simulation of physical operations for setting tonnage rates, designing yards, scheduling repair and maintenance, and preparing schedules give best relationship between speed and fuel consumption.

In addition, payroll, general ledger, dividends and shareholder records are other uses for the computer. The large computer has tended toward centralization. However, the company expects this tendency to reverse through a widespread use of smaller computers on a decentralized basis to process and refine data before it reaches the high speed computer. Information about obtaining a copy of the paper may be directed to the author's company in Montreal, Quebec, Canada.

THE AIR FORCE AUTOMATES ITS "MANPOWER BANK"

D. M. Parnell, Jr., Air Reserve Records Center, Denver, Colorado
MANAGEMENT AND BUSINESS AUTOMATION, August 1960; pages 19-21, 36, 37

Mobilization of 535,000 Air Force Reservists can be handled by the RCA 501 computer system at the Air Reserve Control Center in Denver. About 100,000 personnel record file changes are processed each week. The system identifies individuals who are to receive periodic personnel survey forms, addresses the forms, and makes any necessary follow-up. It also selects and prepares the list of eligibles for promotion by grade breakdown, and prepares labels for the monthly Air Reservist Magazine and the quarterly Medical Training Bulletin. Queries from agencies, such as the Veterans Administration, are handled on a same-day basis.

The system includes eight tape stations on-line, two modules of high-speed memory, a card transcriber, a transcribing card punch, and an off-line high-speed printer. Information is accepted from punched cards or punched paper tape. The latter is prepared on Underwood "Data Flow" units which also produce hard copy information.

Scheduling the complex system involved conducting time and workload studies by day and month, evaluation of peripheral equipment needs, and constant rescheduling to allow for priorities and other factors.

APING MAN ON COMPUTERS

CONTROL ENGINEERING, August 1960; pages 38, 39

Computers are being used both for medical diagnosis and as tools for making models of human systems for study of human behavior and characteristics. These uses were the subjects of papers read at the aviation conference of the American Society of Mechanical Engineers in Dallas.

Management Sciences

YOUR WITS V. THE COMPUTER'S

BANKING, August 1960; pages 54, 174

A bank management simulation or game has been developed by McKinsey & Company, Inc., a group of West Coast banks, and IBM Corp. Teams of four to six members each represent a bank of $50 million in assets. The teams do not compete with each other, and one team's decisions do not affect another's. Rather, each bank plays against a fluctuating national economy.

Points of Interest

These short news items are, unless noted otherwise, abstracted from news releases received during the month. For further information, contact the local office or headquarters of the respective equipment manufacturer.

Potter 906 II high performance magnetic tape handlers (12,000 digits or 60,000 alpha numeric characters per second) will be used on the Bendix G-20 data processing system. (Potter Instrument Co., Plainview, N. Y.)

RCA 501 computer will use the RCA 501 COBOL Narrator, an English language programing system.

RCA 501 Electronic Data Processing Center will be opened by RCA in Chicago, this fall.

Remington Rand Univac STEP has been announced as an abbreviated version of the Univac Solid-State general purpose computer, which can be built up to a full Solid-State as required.

IBM 1001 Data Transmission System is latest in the company's line of Tele-processing, transmitting data at the rate of 12 columns per second. (Computing News, July 1960)

NCR 390 electronic computer is able to maintain "hard copy" files by means of magnetic strips on the back of regular ledger cards. (The Interpreter, August 1960)

Honeywell 400-A package is a new system including the central processor, and three magnetic tape units. The system may be connected with the standard Honeywell 400 system including the central processor, four magnetic tape units, high speed printer and card reader.

IBM 7765 paper tape-to-magnetic tape converter accepts five-track telegraphic code and IBM 8-track code paper tapes and feeds magnetic tape to a computer at 15,000 to 22,500 characters per second. (Management and Business Automation, August 1960)

GE 225 general purpose computer includes an automatic compiler system and data-buffering and priority-assigning componentnent for use with a variety of peripheral equipment. Computer price range is $125,000 to $400,000. (Management and Business Automation, August 1960)

Training

"New Concepts in Planning and Installing EDP" Course #30 presented by Richard G. Canning, Consultant

Date: December 5-9, 1960
Place: New York City (Hotel Biltmore)
Fee: $250
Information: Richard G. Canning, 614 S. Santa Fe Ave., Vista, California

Engineering and Management Course, presented by University of California at Los Angeles

Date: January 23--February 2, 1961
Place: UCLA Campus
Fee: $450
Information: Reno R. Cole, Coordinator, The Engineering and Management Course, College of Engineering, University of California, Los Angeles 24, California

Meetings

NABAC National Convention

Date: October 10-12, 1960
Place: Los Angeles, California
Information: NABAC, The Association for Bank Audit, Control and Operation, 38 South Dearborn St., Chicago 3, Illinois

International Systems Meeting, sponsored by Systems and Procedures Association

Date: October 10-12, 1960
Place: New York, N. Y. (Hotel Commodore)
Information: Systems and Procedures Association, 4463 Penobscot Bldg., Detroit 26, Michigan

National Meeting, Operations Research Society of America

Date: October 10-12, 1960
Place: Detroit, Michigan (Statler Hilton Hotel)
Information: Albert Wallaert, M.D., Grosse Pointe, Michigan

One-Day Technical Symposium, sponsored by Los Angeles and Orange County Chapters of A. C. M.

Date: October 19. 1960
Place: Anaheim, California (Disneyland Hotel)

The Institute of Management Sciences (TIMS) International Meeting

Date: October 20-22, 1960
Place: New York City (Hotel Roosevelt)
Subjects: Behavioral Science and Management Science, Applications and Tools of Management Science, Use of Computers in Simulation
Information: Mr. James Townsend, 30 East 42nd Street, New York 17

Computer Applications Symposium, sponsored by Armour Research Foundation

Date: October 26, 27, 1960
Place: Chicago, Illinois (Morrison Hotel)
Information: Andrew Ungar, Armour Research Foundation, 10 West 35th Street, Chicago 16, Illinois

Institute on Electronics in Management, sponsored by American University School of Government and Public Administration

Date: October 31--November 4, 1960
Place: The American University, Washington, D. C.
Theme: "Current Developments in Automatic Data Processing Systems"
Information: Dr. Lowell H. Hattery, The American University, 1901 F. Street, N. W., Washington 6, D. C.

Business Equipment Exposition

Date: November 1-4, 1960
Place: Los Angeles, California (Memorial Sports Arena)

Eastern Joint Computer Conference

Date: December 13-15, 1960
Place: New York City (Hotel New Yorker and the Manhattan Center)

References

DATA PROCESSING DIGEST does not provide copies of the original material digested or reviewed in this issue. The publishers addresses are listed below for your convenience in writing to them for more complete information.

American Management Association
1515 Broadway
New York 36, New York

Automation Progress
Stratford House
9 Eden Street
London NW 1, England

Banking
12 East 36th Street
New York 16, New York

Berkeley Enterprises Inc.
815 Washington Street
Newtonville 60, Mass.

Communications of A. C. M.
P. O. Box 1184
Chapel Hill, North Carolina

Control Engineering
330 West 42nd Street
New York 36, New York

The Controller
Two Park Avenue
New York 16, New York

Cost and Management
66 King Street East
Hamilton, Ontario, Canada

Data Processing
Gille Associates
22nd Floor Book Tower
Detroit 26, Michigan

Data Processing & Microfilming Systems
10 East 40th Street
New York 16, New York

Datamation
10373 West Pico Blvd.
Los Angeles 64, California

Doubleday & Company
Garden City, New York

Factory
330 West 42nd Street
New York 36, New York

Management & Business Automation
600 West Jackson Boulevard
Chicago 6, Illinois

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505 Park Avenue
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adams associates

COMPUTER CHARACTERISTICS CHART

Catalogued below are the salient features of forty-three U. S.-built, general-purpose, stored-program electronic digital computers for which orders are currently (or until recently were) being solicited. These comprise all such computers known to Adams Associates on July 29, 1960. The characteristics given for all but the first two have been confirmed by their respective manufacturers.

While the rental price shown is not a precisely defined quantity, the computers have been listed in order of decreasing rental to bring systems of comparable size into proximity with one another. A list of the sixteen manufacturers represented, with a cross-reference to the chart for each computer they manufacture, appears at the bottom of the chart, along with footnotes and an explanation of the column headings.

	GENERAL CHARACTERISTICS					INTERNAL SPEED		MAGNETIC TAPE				PERIPHERAL EQUIPMENT					SPECIAL FEATURES					
												Input		Output								
	Average Monthly Rental	Solid-State	Storage Capacity and Type	Word Size	Instruction Addresses	Add Time	Average Access Time	Thousands of Characters per Second	Input-Output Channels	Buffering	Maximum Tape Units	Cards per Minute	Paper Tape Characters per Second	Cards per Minute	Paper Tape Characters per Second	Printer Lines per Minute	Index Registers	Indirect Addressing	Floating Point Arith.	Console Typewriter	Random Access File	Random Inquiry
1 IBM 7030 STRETCH	$200,000	✓	16-262K core	64b	1[1]	2μ[1]	1μ[1]	62	32	MRWC	256	1000[2]		250[2]		[2]		✓	✓	I/O	✓	✓
Information is preliminary, not confirmed by manufacturer. The computer features an interrupt system, an input-output exchange (which relieves the computer of all input-output control) with a variety of peripheral equipment available. Effective speed will sometimes be faster than shown because of use of look-ahead and look-behind features permitting simultaneous access to several core storage units.																						
2 UNIVAC LARC	$135,000	✓	10-97K core	12d	1	4μ	4μ	25 133[1]	10	MRWC	60	[1]	[1]	[1]	[1]	[1]	99	✓	✓	I/O	✓	✓
Information is preliminary, not confirmed by manufacturer. System includes a versatile processor unit which controls all input-output operations. A second computer unit can be added. The fast add time shown is obtained by means of an instruction look-ahead feature. Many types of peripheral equipment are available, including a high-speed film printer. Numeric information can be read at a rate of 200,000 characters per second.																						
3 IBM 7090	$64,000	✓	32K core	36b	1	4.4μ	2.2μ	15-62	8	MRWC	80	250[2]		100[2]		150[2]	3	✓	✓	I/O	✓	
A computer which features multiple read-write-compute by use of a 7606 Multiplexor and up to eight 7607 Data Channels. Each Data Channel acts as a separate input-output unit and as many as ten tape units can be attached. The computer may have equipment for direct transmission of data between it and an external data device.																						
4 IBM 7080	$55,000	✓	80-160K core 1K core	1a	1	12μ[1]	2.2μ 1.1μ	15-62	4	MRWC	40	250[2]		100[2]		150 500[2]	0	✓		O	✓	
A variable-word length computer which has a program interrupt feature. Provision has been made for many combinations of on-line input-output devices, including a 1,000 lpm printer. Add time assumes a five-character field. Simultaneous transmit feature allows internal movement of data in parallel with other computer operations.																						
5 UNIVAC 1105	$43,000		8-12K core 16-32K drum	36b	2	44μ	8μ 17m	25	2	RWC	20	120 300[3]	200	120[3]	60	600[3]	0		✓	I/O			
A completely buffered version of the UNIVAC 1103A with increased storage facilities and faster tape drives. A visual display can be attached for on-line output.																						
6 IBM 709	$40,000		4-32K core	36b	1	24μ	12μ	15	6	MRWC	48	250[4]		100[4]		150[1]	3	✓	✓	O	✓	
The computer can have an auxiliary storage drum of 2,000 to 8,000 words. A maximum of three 766 Data Synchronizers may be attached to a system, each of which has two data channels. Each channel may have up to eight tape units attached. A cathode-ray tube display is also available for output. A 500 lpm and a 1,000 lpm off-line printer are available.																						
7 UNIVAC 1103A	$35,000		4-12K core 16K drum	36b	2	44μ	8μ 17m	13	2	RC, WC[1]	10	120 240[3]	100	120[3]	60	600[3]	0		✓	I/O			
The computer utilizes magnetic tapes with forward and reverse read and a lattice arrangement (addresses on drum spaced according to word times) to reduce drum access time. Tape buffering limited to one word.																						
8 CONTROL DATA 1604	$34,000	✓	8-32K core	48b	1	5μ	4.8μ	30	6	MRWC	96	1300	350	200[4]	60	1000[4]	6	✓	✓	I/O	✓	✓
A computer with two instructions per 48-bit word, overlapped core memory banks for increased speed, real-time clock, and program interrupt feature. It is compatible with IBM tape units.																						
9 RCA 601	$32,000	✓	8-32K core	56b	2[1]	6μ	.9- 1.5μ	22-120	16	MRWC	63	600[4]	1000[4]	100[4]	100[4] 300[4]	600[4] 900[4]	8[1]	✓	✓	I/O		✓
The computer uses variable-length instructions on either a character, word, or half-word basis; operations within the computer are in parallel within these categories. Overlapped core memory banks and the processing of different programs simultaneously are features. Eight index registers are available for each program. Double precision arithmetic is available.																						
10 IBM 704	$32,000		4-32K core	36b	1	24μ	12μ	15	1	RC, WC	10	250[4]		100[4]		150[4] 500[3]	3		✓	O	✓	
The computer can have an auxiliary storage drum of 2,000 to 8,000 words and the use of a 774 Tape Data Selector is available to facilitate off-line printing selection. A cathode-ray tube display is also available for output.																						

	Average Monthly Rental	Solid-State	Storage Capacity and Type	Word Size	Instruction Addresses	Add Time	Average Access Time	Thousands of Characters per Second	Input-Output Channels	Buffering	Maximum Tape Units	Cards per Minute	Paper Tape Characters per Second	Cards per Minute	Paper Tape Characters per Second	Printer Lines per Minute	Index Registers	Indirect Addressing	Floating Point Arith.	Console Typewriter	Random Access File	Random Inquiry
11 **PHILCO 2000**	$30,000	✓	4-32K core	48b	1	15μ[1] 4.5μ[1]	10μ[1] 2μ[1]	90	16	MRWC	256	2000[4]	1000[4]	100[4]	60[4]	900[4]	32		✓	I/O	✓	✓
	A parallel, asynchronous system with a wide variety of instructions stored two to a word. Up to 32 auxiliary storage drums (32,768 words each) are available. Overlapped core memory banks, multiple memory banks and special instructions increase internal speed.																					
12 **IBM 705**	$30,000		20-80K core	1a	1	86μ[1] 119μ[1]	9μ 17μ	15-62	6 10	RWC	60 100	250[4]		100[4]		150[4] 500[3]	0	✓		O		
	A variable-word length computer which can be used as a five-digit word computer. Magnetic tapes are controlled in Models I and II by either a 754 Tape Control, a 777 Tape Record Coordinator, or a 760 Control and Storage unit. In Model III, a 767 Data Synchronizer is used. The use of more than one 767 allows MRWC. Add time assumes a five-character field.																					
13 **UNIVAC II**	$28,000		2K core	12a	1	200μ	40μ	25	2	RWC	16	240[3]		120[3]		600[3]	0			I/O		
	Features two instructions per word and magnetic tapes with forward and reverse read. Off-line equipment includes the Unityper II for direct recording of data on magnetic tape, and a paper-tape to magnetic-tape converter which can also be used to produce paper tape from magnetic tape.																					
14 **IBM 7070** **7074**	$24,000	✓	5-10K core	10d	1	60μ[1] 10μ[1]	6μ 4μ	15-62	4	RWC[1]	40	500[2]		250[2]		150[2]	99	✓[1]	✓	I/O	✓	✓
	A computer which features priority processing (making it possible to interrupt one program, switch over to a second program, execute the instructions in the latter, and then return to the first at the point of departure). Add time is variable by the number of digits in the field to be added. Indirect addressing is limited to scatter and gather operations. MRWC is possible when four channels are used. The rental of the 7074 is $5,300 more per month.																					
15 **HONEYWELL H-800**	$22,000	✓	4-32K core	12d	3	24μ	6μ	64[1]	16	MRWC	64	240[4] 650[4]	200[4] 1000[4]	100[4] 250[4]	60	150 900[4]	64	✓	✓	I/O		✓
	A computer with facility for running up to eight independent programs concurrently. It uses an automatic error correction feature, called Orthotronic count, when reading magnetic tapes in either direction. The computer can be used as a binary machine with a word size of 48 bits. Numeric information can be read at a rate of 96,000 digits per second.																					
16 **BENDIX G-20**	$20,000	✓	4-32K core	32b	1	21μ	8.4μ	60[1]	6	MRWC	500	800[4]	500[4]	250[4]	100[4]	600[4]	63	✓	✓	I/O		✓
	All input-output units may operate either on- or off-line under program control. Input-output supervision can be delegated to control buffers. Variable instruction length permits multiple indexing. Numeric information can be read at a rate of 120,000 digits per second.																					
17 **UNIVAC III**	$20,000	✓	8-32K core	6d	1	9μ	4.5μ	25 133[1]	5	MRWC	32	700[1]		300[1]		700[1]	15	✓		I/O	✓	✓
	A computer featuring a flexible storage word which may have four alphabetic, six decimal, or 27 binary characters. An instruction may process up to four data words. Standard off-line input-output units of the UNIVAC line are available. Numeric information can be read at a rate of 200,000 digits per second. Program interrupt and scatter and gather operations are other features.																					
18 **BURROUGHS 220**	$17,000		2-10K core	10d	1	200μ	10μ	25	1	none	10	300	1000	100	60	150 1500[4]	1		✓	I/O	✓	✓
	A computer featuring a magnetic tape system which can search and scan independently of the central computer. Five hundred million digits of random access memory are available.																					
19 **RCA 501**	$16,000	✓	16-262K core	1a	2	360μ[1]	15μ	22-66	8	RC, WC or RW	63	400[4]	1000	150[4]	100 300	600[4] 900[3]	8	✓[1]		O	✓	
	A variable-word length computer featuring four-character (tetrad) parallel transfer, and magnetic tapes with forward and reverse read and dual recording. Indirect addressing is limited to scatter and gather operations. Add time assumes a five-character field.																					
20 **GENERAL ELECTRIC 210**	$14,000	✓	4-8K core	6d	1	64μ	32μ	30 50	2	RWC	13	400 1500	200 500		60	1000[4]	1			I/O	✓	
	A computer which features on-line and off-line handling of magnetically encoded documents through 1200-document-per minute sorter-readers (of which a two-pocket or a twelve-pocket unit is available). The printer can print magnetically encoded characters. The computer can be used in a double precision (twelve-digit) mode.																					
21 **NCR 304**	$12,500	✓	2-4K core	10a	3	600μ 120μ[1]	60μ	30	8	RW[1]	64	2000[4]	1800[4]	250[3]	60[4]	850[4] 1200[4]	10	✓		I/O		✓
	A computer which uses two words per instruction. The internal commands include sort, merge, pack, unpack and a repertoire of microflow, single-address instructions. Pack and unpack can be used to condense numeric data in connection with the magnetic tape system which uses tapes without a space between records. In processing inactive records, RWC is achieved.																					
22 **UNIVAC File Computer I**	$12,000		20 core 1K drum	12a	3	8.6m	.9m 3.1m	10.4	10	RWC	31	150 240[3]	200	150 120[3]	60	600[4]	0			I/O	✓	✓
	A computer which can have up to ten general storage drums of 180,000 characters each (average access time is 17.6m). A search command for locating records on the drum is incorporated. The computer can be used in a scan mode to cycle through 32 possible input-output units. An off-line sort-collate unit is available.																					
23 **UNIVAC SS 80/90**	$9,000	✓	4K drum 1K fast	10d	1[1]	85μ	1.7m .425m	25	1	RC, WC	10	450 240[3]		150 120[3]		600[4]	3				✓	
	The last part of the instruction word indicates the address of the next instruction. In addition to working with binary coded decimal, some operations can be performed in binary. Random access drums (Randex) at six to 24 million characters are available.																					
24 **IBM 650**	$9,000		1-4K drum 60 core	10d	1[1]	.7m	2.4m .1m	15	1	RC, WC	6	155- 250	60	100- 250		150[4]	3	✓			✓	✓
	The last part of the instruction word indicates the address of the next instruction. Tape records can be written in either BCD mode (six-bit characters) or straight numeric form (four-bit characters). It is possible to use the 774 Tape Data Selector as an off-line tape editor. The Ramac units can store up to twelve million characters per unit, of which there can be a maximum of four units.																					
25 **HONEYWELL H-400**	$8,700	✓	1-4K core	12d	3	220μ	8μ	64[1]	3	RW	6	650	1000	100 250	60	900	3					
	A computer having some of the same features as the H-800. It offers Orthotronic count, magnetic tapes, and the same word flexibility, i.e., eight alphabetic characters, twelve decimal characters, and 48 binary bits. Numeric information can be read at a rate of 96,000 digits per second.																					

	Average Monthly Rental	Solid-State	Storage Capacity and Type	Word Size	Instruction Addresses	Add Time	Average Access Time	Thousands of Characters per Second	Input-Output Channels	Buffering	Maximum Tape Units	Cards per Minute	Paper Tape Characters per Second	Cards per Minute	Paper Tape Characters per Second	Printer Lines per Minute	Index Registers	Indirect Addressing	Floating Point Arith.	Console Typewriter	Random Access File	Random Inquiry
26 **GENERAL ELECTRIC 225**	$8,000	✓	8-16K core 8-32K drum	21b	1	40μ	20μ	15 55	7	MRWC	64	400	100 1000	100	60	600	3	✓	✓	I/O	✓	✓
The word size of this computer can be 21 to 38 bits or 3 to 6 decimal digits. Facilities for handling magnetically encoded documents are available through 1200-document-per-minute sorter-readers. The computer can be connected with a transmitter-receiver unit for communication purposes.																						
27 **BURROUGHS 205**	$8,000		4K drum 80 fast	10d	1	1.7m	8.5m .85m	6	1	none	10	300	540	100	60	150	1		✓	I/O	✓	✓
A computer system with fully buffered and edited card input-output and line printer. Independent search on magnetic tape for up to one million 200-character records, and a full paper-tape system are features of this equipment.																						
28 **IBM 1401**	$7,500	✓	1.4-16K core	1a	2[1]	230μ[1]	11.5μ[1]	15-62	1	none[1]	10	800		250		600	3					
A variable-word length computer using variable-length instructions. With the 1403 Chain Printer, this system can serve as an off-line input-output device for the 7070, 7080, and 7090 systems. Add time assumes a five-character field. A 500-character per second paper-tape reader and output typewriter are available. Magnetic tape start time may be shared with computing.																						
29 **RCA 301**	$5,000	✓	10-20K core	1a	2	189μ[1]	7μ	7.5	2	RC, WC or RW	12	600	100	100	100	600	1	✓			✓	
A variable-word length, character-addressable system featuring magnetic tapes with forward and reverse read. Random access is available through disc Record Files (up to five, each with a capacity of 4.6 million characters). A special model featuring faster speeds in arithmetic and data transfer operations plus floating point arithmetic is also available. Add time assumes a five-character field.																						
30 **DEC PDP-3**	$4,400[5]	✓	4-32K core	36b	1	10μ	5μ	15	4	RC, WC	128		400		60		511	✓		I/O		
A computer which features 511 words of main memory as index registers. The multiplication rate is 40,000 per second (25 microseconds complete), and the memory is expandable to 262,144 words. An optional feature is a cathode-ray tube display unit with light pen.																						
31 **IBM 305**	$3,600[5]		100 core 2000 drum[1]	1a	2	30m	10m	15	1	RC, WC	4	125	20 60	100 200		30-50[1] 150	0			I/O	✓	✓
The computer has a 200-instruction capacity drum and the ability to call in additional instructions from the disc file, which is available in modules of five to 40 million characters (average access time is 250m). Input editing, logical decisions and character analysis are usually made through the 305 Control Panel. Each output unit has a separate control panel for format control. The "Stick" printer prints one character at a time.																						
32 **EL-TRONICS ALWAC III-E**	$3,600[5]		4-8K drum	33b	1[1]	1m	4m	21	1	RC, WC	16	100	200	100	60	150	1			I/O		
Two, three or four instructions may be contained within one word. Hexadecimal notation may be used without affecting the operation of the computer. Magnetic tape units can be searched simultaneously with computer operations.																						
33 **AUTONETICS RECOMP II**	$3,000	✓	4K disc 16 fast	40b	1	9.5m 1.49m	9m .95m						400		20		0		✓	I/O		
A desk-sized computer with magnetic disc memory, control console with decimal readout, and logical echo checking of output. The 49 commands are stored two per word and feature square root and absolute value instructions in both fixed and floating point operations.																						
34 **RPC 9000**	$2,500	✓	72 delay[1]	12a	1	.23m	.8m	52[1]	15	MRWC	120	400	60 500		30 300	150 1000	0	✓		I/O	✓	✓
A computer featuring external data memory on endless loops of magnetic tape, each tape loop storing up to one million characters. Internal memory consists of nickel wire magnetostrictive delay lines and is easily expandable. Cross communication between input and output units is by separate buffers, which speed up over-all operation and allow multiple-input, search-on-content, and output operations. The 52,000 characters per second is a calculated search rate. Rental includes one magnetic tape unit.																						
35 **DEC PDP-1**	$2,200[5]	✓	1-4K core	18b	1	10μ	5μ	15	2	RC, WC	64		400		60		0	✓		I/O		
A parallel-circuit computer which features logical instructions, twelve types of shifts, and ten test instructions. The memory is expandable to 28,672 words. Optional devices include a cathode-ray tube display with light pen, magnetic tape and others.																						
36 **RPC 4000**	$1,800	✓	8K drum 128 fast	32b	1[1]	1.0m	8.5m 5.0m						60 500		30 300		1			I/O		
The last half of the instruction word indicates the address of the next instruction. A desk-sized computer featuring a repeat execution command which allows groups of from one to 128 successive words to be operated on within memory by one command at high speed.																						
37 **IBM 1620**	$1,600	✓	20K core	1d	2	560μ[1]	20μ						150		15		0			I/O		
A variable-word length computer with overlapped memory banks for increased speed. Alphabetic characters are represented by two decimal digits. Magnetic tapes may be added. Add time assumes a five-character field.																						
38 **BENDIX G-15**	$1,500[5]		2K drum 16 fast	29b	1[1]	1.08m	14.5m .54m	.43	1	RC, WC	4	100	400	100	60	100	0			I/O		
Last part of instruction word indicates address of next instruction. Magnetic tapes, cards, graph plotters, and a digital differential analyzer are available. Alphanumeric input-output is completely buffered. Special accessories permit on-line use with analog systems.																						
39 **CONTROL DATA 160**	$1,500[5]	✓	4K core	12b	1	12.8μ	6.4μ	15 30	1	none[1]	20	1300	350		60	1000	0	✓		I/O	✓	✓
A desk-sized computer featuring parallel mode of operation and versatile input-output capabilities for handling a complete line of peripheral equipment. The instruction code allows no address, direct address, indirect address, and relative address modes. Magnetic tape start time may be shared with computing.																						
40 **PACKARD BELL PB 250**	$1,200[5]	✓	1.8-16K delay 16 fast	22b	1	24μ	1.5m .09m	2	1	none	6		10 300		10 110		1			I/O		
The commands include double-precision arithmetic, variable-length multiply, divide, and square root. Peripheral equipment includes card equipment and analog-to-digital and digital-to-analog converters. An input-output rate of up to 85,000 words per second is possible. Internal storage is magnetostrictive delay lines.																						

	Average Monthly Rental	Solid-State	Storage Capacity and Type	Word Size	Instruction Addresses	Add Time	Average Access Time	Thousands of Characters per Second	Input-Output Channels	Buffering	Maximum Tape Units	Cards per Minute	Paper Tape Characters per Second	Cards per Minute	Paper Tape Characters per Second	Printer Lines per Minute	Index Registers	Indirect Addressing	Floating Point Arith.	Console Typewriter	Random Access File	Random Inquiry
41 **RPC LGP-30**	$1,100		4K drum	31b	1	2.26m[1]	8.5m						200		20		0			I/O		
A desk-sized computer featuring an interlaced pattern of word addresses on the drum, which reduces memory access time. An oscilloscope displays contents of control register, instruction register, and accumulator.																						
42 **BURROUGHS E-101**	$1,000		220 drum	12d	1	50m	10m						20		10	60	2			I/O		
A desk-sized computer using pinboard programming. Multiple paper-tape input and output and card input and output are optional. Simplicity of programming and operator control are major characteristics of this equipment.																						
43 **MONROBOT XI**	$700	✓	1K drum	32b	1	9m	6m					15	20	15	20					I/O	✓	
Limited random access inquiry is available via the drum and one or two paper-tape loops. Input-output facilities, up to any combination of three units, are time-shared.																						

EXPLANATION OF COLUMN HEADINGS

Average Monthly Rental: Rough approximation of what a customer might expect to pay for a complete system with basic peripheral equipment and tapes when available. With so many options available on every system, no precise standard of cost measurement is possible. The figures given should not be used for direct comparison of competitive equipments.

Solid-State: Checkmark indicates that the central system contains few, if any, vacuum tubes. Presumably this, in turn, implies greater reliability, smaller size, lower power requirement, and less heat generation than would be the case were vacuum tubes used.

Storage Capacity and Type: Number of words of addressable internal storage available, K representing "thousand" (e.g., "16-262K core" for the RCA 501 indicates that the internal storage consists of magnetic cores and that from 16,000 to 262,000 words are available at the user's option, a word in this case being a single alphabetic character as shown in the Word Size column). "Fast" indicates a serial-type, fast-access secondary storage, found primarily in drum computers.

Word Size: Number and type of digits comprising one word in storage. (a = alphanumeric, d = decimal, b = binary)

Instruction Addresses: Number of separate storage addresses in a conventional instruction.

Add Time: Time required to acquire and execute one add instruction, in millionths (μ = microseconds) or thousandths (m = milliseconds) of a second. In the case of drum machines, where the add time is lower than the average access time, maximum optimization has been assumed.

Average Access Time: Storage cycle time (including, for example, half of the drum revolution time in the case of drum storage) in millionths (μ) or thousandths (m) of a second.

Thousands of Characters per Second: Transfer rate from computer to tape or vice versa, measured in six-bit characters (one alphabetic, one decimal, or six binary digits) unless otherwise noted.

Input-Output Channels: Number of separate groups of magnetic tapes, usually with a separate buffer for each channel.

Buffering: Combinations of the three operations of reading magnetic tape (R), writing it (W), and computing (C), that can be performed simultaneously. MRWC indicates that multiple reading and writing is possible simultaneously with computing.

Maximum Tape Units: Maximum number of tape units connectable to and addressable by the computer, without regard to simultaneity.

Peripheral Equipment: Speed of each available punched card, punched tape, and printer equipment available. See footnotes for meaning of superscript numbers.

Special Features: Checkmark indicates that some form of the special feature in question is obtainable. In the case of index registers, the maximum available number of such registers is shown, while in the case of console typewriters, O and I/O are used to represent typewriters usable for output or both input and output. Floating point arithmetic can, of course, be programmed in any system in which it is not available as a built-in feature; only built-in features are marked here.

FOOTNOTES

[1] — See remarks immediately beneath the computer data in question.

[2] — The IBM 1401 system (entry #28 in the chart) is available for use as an off-line input-output device.

[3] — This peripheral equipment is available off-line only (i.e., it can be connected to a magnetic tape unit independently of the central computer).

[4] — This peripheral equipment is available with the same characteristics both on-line and off-line.

[5] — The cost of magnetic tape units has not been included.

INDEX OF COMPUTER MANUFACTURERS